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THE COWPEA WEEVIL

(*Pachymerus chinensis*)

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INTRODUCTION

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The cowpea has found a place in Oklahoma agriculture which warrants its continued use as a field crop.

One of the chief difficulties encountered by the agriculturists and seedmen has been the storage of the cowpea seed in such a way as to prevent damage from the cowpea weevil. **Nevertheless the seed can be stored and kept safely throughout the year,** provided proper treatment is given to control infestation.

There has been such an incessant demand throughout the State each year that I have decided to publish this circular on the cowpea weevil. Consequently, through the able assistance of Mr. J. A. Krall, an advanced student of this department, I have had some investigations made with a hope of ascertaining the best methods for storing cowpeas in order to insure them from possible damage by the cowpea weevil, which has been causing an almost total destruction in the bin of the seed peas of this State.

The results obtained from the experiments by Mr. Krall have for the most part been compiled by him. The remedies best adapted for preventing damage to the pea, as described by him, I have briefly summarized as follows:

REMEDIES FOR CONTROLLING THE COWPEA WEEVIL*

I—Hot Water Treatment

Sack the seed in quantities of from one-half to one bushel in a sack. Use sacks of loosely woven material, such as gunny sacks. Immerse the seeds in water having a temperature of 130° F.

Submerge the seed 1 minute.
Withdraw the seed 2 minutes.
Submerge the seed 1 minute.

Then spread out to dry. As soon as they are dry they may be placed in a weevil-proof non-infested bin or sacked in sacks made of heavy canvas, or similar material (ordinary gunny sack or flour sack material is not sufficient).

II—Dry Heat Treatment

Heat the seeds in a steady temperature of 130° F. for a period of from two to four hours. Heat does not penetrate rapidly in bulk seeds, consequently seeds must be arranged so as to receive a uniform treatment.

III—Carbon Bisulphid Treatment

One pound of carbon bisulphid to forty bushels of seeds in air tight bins. Place the carbon bisulphid in shallow pans on the surface of the seeds. Select a warm day for the treatment and do not ventilate before the expiration of twenty-four hours. (Carbon bisulphid will explode if fire is brought in contact with it.)

IV—Kerosene Treatment

Kerosene one pint to ten bushels or 600 pounds of peas. Spread the peas thinly and evenly on a canvas or floor, then spray uniformly with an atomizer, hand spray pump or very fine sprinkler, then shovel the peas bringing treated and untreated seeds together until all have an equal coating of the kerosene.

NOTE.—If the peas are not infested before storage, they will need no treatment and cannot become infested in storage if proper bins or sacks are used for storing them. Thick, firmly woven material should be selected for the sacking of peas, and in case of doubt they should be stored in double sacks, i. e., two sacks, one containing the other.

NOTES ON CONTROLLING THE COWPEA WEEVIL

(*Pachymerus chinensis*)

BY JOHN A. KRALL

This species of weevil was formerly classified as Bruchus chinensis, however, later the United States Department of Agriculture through the Bureau of Entomology, Bulletin No. 96, by F. H. Chit-

enden, gave it a new classification. This particular weevil has proved itself to be a pest of no small importance in the cowpea industry of this State. In view of this fact, the writer has endeavored to determine some practical means of combating the insect in stored peas where practically all of its damage is done.

Owing to a limitation of time it was deemed advisable to consider only those methods of procedure that are practically inexpensive and are accessible to the seedsman and the farmer. Since nearly every seedsman has access to a local ice plant or cold storage house, the first experiment was conducted along the lines of cold storage. Effort was made to determine the effectiveness and economy of such treatment. With the exception of a few incidentals, the work was conducted under favorable circumstances.

While other experiments were limited in extent, they may be of some aid in concluding further investigations, and possibly be of direct interest to those concerned.

Cold Storage Experiment

Through the courtesy of the Lahman-Keiser Company, owners of the local ice plant, an experiment was conducted to determine the efficiency and practicability of placing cowpeas in cold storage for the prevention of weevil damage.

On October 28, 1912, several quantities of cowpeas were put into cold storage. A self-recording thermometer was placed alongside the peas and the temperature recorded in weekly periods for three months, after which time the records covered weekly periods taken every two weeks, and later every month until the experiment closed. In this manner an accurate range of temperature was secured.

After the first three weeks of the cold storage experiment, germination tests were made of the stored peas. The following table shows the length of storage, average temperature, and germination test of the cowpeas subjected to cold storage:

TABLE I

Showing period of storage, average temperature, and germination test of cold storage cowpeas:

Length of Storage	Av. Temp.	Germination	Remarks
10-28-11-25, '12, 28 days	27½ F.	76 Check 75	Fungus growth injured test.
10-28-12-25, '12, 58 days	26 F.	92 Check 98	
10-28, '12, 2-1, '13, 96 days	31 F.	90 Check 91	
10-28, '12, 3-1, '13, 123 days	28 F.	87 Check 84	Fungus growth injured test.
10-28, '12, 4-1, '13, 154 days	27 F.	90 Check 88	
10-28, '12, 5-1, '13, 184 days	27 F.	86 Check 88	
Original seed tested fall 1912		95 Check 95	

The general effect of cold storage on the germination of cowpeas (see Table 1) shows that with the exception of the first month there

was only a minor decrease in germination. The original seed in the fall of 1912 tested 95%, and the same seed at the end of the experiment tested 86%, or a decrease of 9%. Beyond a change in color to a darker shade, there were no other noticeable external changes in the cowpeas.

These results are better than were anticipated, for throughout the test the temperature was more or less irregular, and at times the surrounding atmosphere was too moist for successful storage. The local ice plant was not equipped for commercial storage, and such conditions are rarely met with in commercial storage plants.

Effect on Weevil

A parallel experiment similar to that described in the foregoing discussion was tried in order to determine the effect of cold storage on the cowpea weevil with the following results:

Weevils were placed in the same medium as were the cowpeas. After subjection to a temperature ranging from 15° to 31° F. for a period of seven days they were taken out and examined. Apparently all of the weevils were dead, but after a few hours' exposure to a temperature of 85° F. they were again subjected to a temperature of 15° F. After a period of two days they were again placed in a living room temperature, but failed to revive. Eggs similarly treated failed to hatch. Whether these results could be relied on for general practice can only be determined by a more elaborate experiment than the writer was able to conduct; however, observation shows that when any of the stages in the life cycle of the weevil are subjected to a temperature of 32° F. or below for a period of time they will not mature.

Notes on Cold Storage

While storage houses are managed to meet local conditions, they observe general rulings that are applicable to most storage companies. The usual rent of rooms or small compartments is at the rate of 4 to 5 cents per cubic foot per month. These rates are the charges for each month or fraction of a month unless otherwise specified, and in all cases fractions of months to be charged as full months. Charges to be computed in all cases when possible upon the marked weights and numbers of all goods at the time they are received. All storage bills are due and payable upon the delivery of the whole lot or balance of a lot of goods, or every three months when goods are stored for more than three months. Unless special instructions regarding insurance accompany each lot of goods they are held at owner's risk.

The foregoing experiments show that cold storage is an effective means of controlling the cowpea weevil, and its practicability is governed by conditions. Only in a few cases would farmers find it advisable to store grains by this method, and for this reason the experiment was conducted for the benefit of the seedsman. Parallel experiments show that an enormous loss occurs when cowpeas and

ther grains are stored by usual methods. Especially is this so in the outhern States, and since northern-grown seeds are subjected to eezing conditions while in storage, it may be possible that other rains could be stored with advantage by the commercial seedsman.

Notes on Hot Water Treatment

Method of Procedure.—In this experiment a tank of ten gallons' apacity was used. The water being heated by means of a steam jet, hich made it possible to keep the water at any desired temperature, nd throughout the experiment the temperature was changed with ase. A Fahrenheit thermometer was partly sumberged in the tank, uspended by means of a string so that the readings were always vailable. The grain to be treated was placed in closely woven sacks common flour sacks) which retained any weevils that were with the owpeas.

In testing the effect of the hot water on the peas and weevils, uantities averaging one to eight pecks were used. To determine the uantities of seed easiest to work with in actual operations, one-half ushel and one bushel were used.

TABLE II

Hot water treatment germination test. Notes on effect on wee- ils:

Degrees.	Time Immersed.	Germination. Test	Notes on Effect on Weevils.
120° F.	In 1 minute		
	Out 2 minutes		A large percent survived the treat-
	In 1 minute	90%	ment after exposure to air.
120° F.	In 2 minutes	64%	A few survived.
125° F.	In 1 minute	89%	Not a good treatment.
125° F.	In 1 minute		
	Out 1 minute	85%	A few protected weevils survived.
130° F.	In 1 minute	66%	Killed a large percent.
130° F.	1 in, 2 out, 1 in	85%	All killed; germination best under this method.
130° F.	In 2 minutes	45%	All killed.
135° F.	In 1 minute	55%	
135° F.	In 1, out 2, in 1	82%	Weevils killed on first emersion from now on.
135° F.	3 minutes	55%	
135° F.	4 minutes	84%	Fungus growth bad.
140° F.	1 minute	44%	Caused by spores in tap water.
140° F.	In 1, out 2, in 1	65%	
140° F.	3 minutes	47%	
140° F.	4 minutes	29%	
145° F.	1 minute	46%	
145° F.	In 1, out 2, in 1	40%	
145° F.	3 minutes	32%	
145° F.	4 minutes	8%	
150° F.	1 minute	63%	
150° F.	In 1, out 2, in 1	37%	
150° F.	3 minutes	28%	
150° F.	4 minutes	3%	
155° F.	1 minute	41%	
155° F.	2 minutes	12%	Mould injured test.
155° F.	3 minutes	2%	

Original test, 95% 1912 crop.

RESULTS

(See Table II)

Remarks

1. It was found that the process of subjecting one peck of peas one minute in, two minutes out, and one minute in, lowered the temperature 3° F. in a room where the temperature was about 90° F. It is seen that allowance and due preparation must be made to meet the difference in temperature of the hot water tank and the surrounding atmosphere. To accomplish this it seems advisable to have two dipping tanks, No. 1 to drop the seeds into so as to raise the temperature near that of No. 2, which must be kept at a constant temperature.

2. From one-half to one bushel of seed is about the right quantity to handle. Larger amounts are unhandy and offer more or less protection to the weevils.

3. Methods of heating water (thresher engine most constant and convenient), several farmers treat their seed together.

4. Final condition of seed after drying seems to indicate that the hulls are loosened more or less by the treatment. The percentage increasing as the temperature rises above 135° F.

5. Safe temperatures are 130° to 135° F. (Treatment No. II.) Difference in germination tests show a decrease of 10% and 13% by these two treatments.

Dry Heat Experiment

Procedure.—In conducting this experiment a laboratory oven, heated by means of a Bunsen burner, was used. Small grain sample bottles were used to put peas and weevil in. To note the effect of the treatment on the weevils a series of six bottles was used, which were examined at stated periods of one-half hour, one, two, four, seven and ten hours. In this manner a rapid transfer from the oven bottle one, two, three, etc., did not materially affect the temperature of the others. Also the thermal death point of the weevils could be determined. Large, active weevils were selected.

Results.—Effect on Weevils. As the oven became heated to a temperature of 130° F. the weevils became very active. After twenty-five minutes a few showed signs of being overcome. At forty minutes all were killed. Examination four months later showed that no larvae or eggs had matured in those peas subjected to 130° F. for two hours and above.

TABLE III

Dry heat experiment.

Temp. F.	Time Exposed.	Germination Test.	Remarks.
130° F.	40 minutes		Adult weevils killed.
130° F.	1 hour		Result lost.
130° F.	2 hours		
130° F.	4 hours	98%	No eggs or larva matured.
130° F.	7 hours	94%	No eggs or larva matured.
130° F.	10 hours	96%	Stored 7 months, 79%.

Remarks.—Due allowance must be made for heating bins to higher temperatures, therefore the lower temperatures seem advisable.

Carbon Bisulphid Treatment

Procedure.—Seed treated twenty-four hours to carbon bisulphid vapors in the proportion of 16 drams to 4 cubic feet, after treatment grain was stored in a tight grain sack and subjected to ordinary granary conditions.

Results.—The weevils were killed, and at the expiration of four months there were no weevils present.

Remarks.—This experiment was not conducted as long as the writer had desired, and the true value was not ascertained. However, it is the opinion of the writer that this treatment has little or no effect on the larvae or eggs. Further investigation should be conducted.

One pound of carbon bisulphid to forty bushels of seed has been recommended.

Kerosene Treatment

This experiment was not conducted on a large scale, since the writer was determining the direct results of kerosene on the weevils and the germination of the cowpeas.

Procedure.—A gallon jar was used in which was placed some infested seed and a small piece of cotton cloth saturated with kerosene. A few stirrings with a stick was sufficient to give all the seeds a coating or film of the oil.

In another instance a flour sack with one gallon of cowpeas, in which about a spoonful of kerosene had been poured, was held at both ends and the cowpeas passed back and forth. A few such movements were sufficient to incorporate the kerosene.

Results.—Weevils subjected to coal oil treatment were killed. It was observed that they must receive a good coating of the oil in order for it to be thoroughly effective.

Cowpeas were stored six months and showed a germination test of 91%. No sign of infestation was observed. Cowpeas treated are

NOTE.—A similar test was made at 120° F., but was not satisfactory. Owing to poor equipment the higher temperature could not be obtained. It is the opinion of the writer that 130° F. and 135° F. are good working temperatures, since germination tests show that higher temperatures are injurious to the seeds when exposed too long.

not apt to be visited by live adults, owing to their dislike of the odo of the coal oil vapor.

Remarks.—Kerosene in the proportion of one quart to twent bushels has been recommended. The exact amount can best be de termined by noting when the cowpeas receive a light coating or filn of the oil. Apparently careful use of kerosene does not injure th germination, but this matter should receive further consideration.

For treatment of large quantities of seed the procedure followe in treating small grains for smut seems to be very practical. "Hea the cowpeas on a tight floor and spray the kerosene on with a sprink ler, then shovel the mass from side to side, as in mixing concrete." Again, a device constructed on the order of a revolving churn woul probably be faster and do better work, since there is a rapid inter changing of cowpeas under such a treatment, and consequently a more even distribution of the kerosene.

This treatment practically insures against a second infestation since the weevils dislike the odor of kerosene. Should further inves tigation show that the germination is not too greatly affected, thi ought to become one of the common treatments. Since it may have qualities that will aid in combating rodents in the field after seeding time.

General Observations

Number of eggs on seed one to six. Average two in early fall Those peas badly infested, forty to fifty on one seed. Weevils in clined to deposit eggs on new seed. Observed that immature or in jured seeds are not oviposited on.

Position of egg on seed. Inspected several thousand, eggs usu ally laid some distance from the hilum or germ center; very seldom is germ injured even in bad infestations. Same in pods or out of pods

Eggs near end of oviposition season become smaller and may ac count for dwarfed weevils often seen in bad infestations.

Rate of oviposition about six to fourteen per day. Number o eggs per adult varies from forty-eight to 110 eggs. One female wee vil oviposited 110 in seven and one-half days.

Adult weevils noticed as early as October 15 on 1912 crops fron field. The general appearance of first brood being from Novembe 15 to 25.

Seed stored at living temperature from fall of 1912 to spring o 1913—eight months—badly infested; germination 8%.

Treated kerosene, six months, tested 91%.

Experiment with eggs in light or dark—145 peas—sixty-eight wee vils emerged on light side, sixty-nine in dark. Eight different.

Rarely an egg deposited on injured or immature seeds.

Treated cowpeas should not be stored in infested bins or sacks Storage in tight grain bags is recommended as a safeguard agains further infestations.

The variety of cowpea used in the foregoing experiments wa the "Crowder".